

Inuit myopia: an environmentally induced "epidemic"?

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Summary: Among Inuit less than 30 years old the prevalence of myopia is far in excess of that of their elders. This is especially true for females. There seems to be little, if any, genetic contribution to this "epidemic" of myopia in the young. The age and sex distribution indicates the likelihood of an environmental factor, probably cultural, being responsible for the current pattern. Other data implicate school attendance as a possible etiologic factor.

Résumé: La myopie chez les Inuits: "épidémie" provoquée par le milieu?

Parmi les Inuits âgés de moins de 30 ans la prévalence de myopie dépasse largement celle constatée chez leurs aînés. Ceci est surtout vrai chez les femmes. S'il devait y avoir un facteur génétique à cette "épidémie", il est certainement d'importance minime. La distribution par sexe et par âge indiquent plutôt qu'il s'agit probablement d'un facteur dû au milieu, vraisemblablement d'origine culturelle. D'autres données semblent impliquer la fréquentation à l'école comme facteur étiologique possible.

In myopia there is an inability to focus images of distant objects on the retina. Such a defect may be due to abnormalities of axial length of the eyeball, corneal thickness and curvature, or power of the crystalline lens. The cause of such defects is not known, although genetic, nutritional and environmental factors have been postulated. Results of a previous study¹ indicated that among Inuit (Eskimos) myopia is four to eight times more frequent in younger persons (aged 15 to 30 years) than in older persons. Among the young people the occurrence of myopia has been termed an "epidemic" because its prevalence far exceeds that expected from the experience of their elders.

The current study was designed to examine the relationship of the increasing prevalence of myopia to genetic, growth and environmental variables by testing the following hypotheses:

- Genetic: Parents and other relatives of myopes have a higher frequency of myopia than members of an unselected Inuit population of similar age and sex.
- Growth and developmental: Height and weight characteristics in myopic Inuit differ from those of nonmyopes of the same age and sex.

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- Environmental: Myopic Eskimos have more schooling than do nonmyopes of similar age and sex.

Methods

We selected two isolated Canadian Arctic communities, Gjoa Haven, NWT and Spence Bay, NWT for participation in the study. Each settlement contains fewer than 500 persons, has few whites and is not easily accessible except by air. Two nurses at a nursing station serve each community. The people had not been examined in the previous survey,¹ nor had they participated in any recent health surveys. The principal investigator (R.W.M.) visited both communities 3 months before any data were collected. He explained to the nurses, health committees and influential natives the purpose and nature of the survey.

In February 1974 the screening team (epidemiologist, nurse and ophthalmic technician) surveyed the residents of Spence Bay and Gjoa Haven. They identified, by illiterate E chart and pinhole correction, all persons with possible myopia (visual acuity 20/40 or worse, with improvement by pinhole correction). They also recorded the height and weight of each subject.

All "possible myopes" aged 15 to 30 years were considered probands and were interviewed, with an interpreter, to ascertain pedigrees. Establishing pedigrees among Inuit is complicated by language problems, lack of surnames, frequent adoption at birth or later and frequent arbitrary name changes. However, because we used a knowledgeable local interpreter, we are reasonably confident of the pedigrees constructed. The Inuit cooperated fully with the study: all but three of the eligible and available adults attended for screening and no proband refused an interview.

One week after the screening session the ophthalmic team (ophthalmologist, nurse and ophthalmic technician) screened the few persons missed by the first team and examined all persons (probands or not) with possible myopia or other visual problems. The examination included pupillary dilation and retinoscopy. Both spherical and cylindrical components of refractive error were recorded. Analyses of data by spherical component only or spherical equivalent produced almost identical results.

Survey data were supplemented by eye examination data from health records maintained by Health and Welfare Canada at Yellowknife, NWT. This enabled us in many instances to ascertain the refractive status of relatives named

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in the pedigrees who were living outside the study communities.

Three months after the survey and ophthalmologic verification the study nurse returned to ask all survey participants (as well as the teachers) the total duration of their attendance at school, as well as questions concerning the frequency and duration of absences from school. In most instances she did not know the refractive status of the person being questioned.

Because results were similar for both study communities, data were pooled.

Results

Table I summarizes the age and sex distribution of myopes in the two communities. (More detailed data are available on request.) The prevalence of myopia was significantly greater among the young (those less than 30 years of age) of both sexes, although the proportion of myopes was greater among females than among males. Most myopia was bilateral, mild and frequently accompanied by astigmatism of varying degree.

Table II displays the prevalence of myopia among relatives of the probands, as compared with expected values calculated from sex- and age-specific population frequencies. The number of parents with myopia (4) slightly exceeded the expected number (1.230). However, if a Poisson distribution is assumed, the 95% confidence limits for the observed frequency are 1.09 and 10.24; this interval includes the expected value of 1.230. The 90% confidence limits are 1.37 and 9.15; this interval does not include the expected value of 1.230. Thus, the parental frequency exceeds the expected with a significance between 0.05 and 0.1.

Table III compares the height of myopes and nonmyopes.

Table I—Prevalence of myopia among Inuit, by sex and age

Refractive status	Numbers of subjects			
	Males*		Females*	
	15 - 29 yr	≥ 30 yr†	15 - 29 yr	≥ 30 yr†
Myopia	10	3	25	5
Nonmyopia	44	92	33	86
Total	54‡	95‡	58‡	91‡

*Differences between sexes² (all ages): $\chi^2_1 = 7.86$; $P < 0.01$.

†Differences between age groups (within each sex group): $\chi^2_2 = 47.14$; $P < 0.001$.

‡Overall test of significance: $\chi^2_3 = 54.99$; $P < 0.001$.

Table II—Prevalence of myopia among relatives* of Inuit myopes, compared with expected values

Relationship	No. in whom refractive status was ascertained	No. with myopia	Expected no. of myopes†
Parent			
Father	22	2	0.771
Mother	17	2	0.459
Sibling			
Brother	33	3	3.248
Sister	32	9	9.017
Grandparents	9	0	0.227
Aunts and uncles	111	6	7.244
All first- and second-degree relatives	224	22	20.966

*Those less than age 15 years.

†From age- and sex-specific population frequencies.

Application of unpaired t-tests showed that there were no height differences between myopes and nonmyopes for either sex or age group.

We also found no weight differences between myopes and nonmyopes. Calculation of the ponderal index* demonstrated no major differences.

Tables IV and V provide data concerning attendance at school. Both male and female myopes had had more schooling, although the differences do not quite attain significance. Myopes also attended school more regularly than did nonmyopes ($P < 0.05$).

Discussion

Various authors have documented and tried to explain the low prevalence of myopia among primitive peoples. The papers have been summarized by Post,³ who has attempted to explain the phenomenon on the basis of a relaxation of genetic selection. Our data demonstrate a prevalence increasing too quickly to reflect a sudden genetic selection. The frequencies observed in Table II fit the expected values extremely well, indicating no support for the hypothesis that probands' relatives have an increased prevalence of myopia, as would be expected if the condition had a strong genetic or familial tendency. Therefore, the previous theory of selection relaxation would not appear useful in explaining current or past Inuit refractive patterns.

We are unable to support the hypothesis that myopes' relatives are likely myopic. The current cohort of young myopes does not appear to consist of offspring of a few older myopes, nor do the pedigree data suggest that the "epidemic" can be accounted for by a sudden influx of "white" genes.

*An index of body mass determined by dividing the height by the cube root of the weight.

Table III—Mean heights of Inuit, by age, sex and refractive status

Refractive status	Mean height (cm)*			
	Males		Females	
	15 - 29 yr (N = 54)	≥ 30 yr (N = 95)	15 - 29 yr (N = 58)	≥ 30 yr (N = 91)
Myopia	165.10	164.33	156.28	154.60
Nonmyopia	165.05	171.61	156.61	152.31

*Differences among height were not significant.

Table IV—Record of school attendance of Inuit aged 15 to 29 years and refractive status

	Males		Females	
	Myope	Nonmyope	Myope	Nonmyope
Years registered in school (mean)	9.10	6.34	8.20	6.70
Standard deviation	3.25	4.23	4.44	4.00
Probability (t-test)	0.059		0.189	

Table V—School attendance pattern of reinterviewed Inuit aged 15 to 29 years (both sexes), by refractive status

Pattern	Myopes*	Nonmyopes*
Regular attendance	27	41
Frequent or prolonged absences	2	17

*Difference between groups: $\chi^2 = 4.52$; $P < 0.05$.

Although myopia is widely believed to have a hereditary element the exact mechanism of transmission is not clear; some authors believe its inheritance to be governed by an autosomal dominant gene, whereas others favour transmission by an autosomal recessive gene.⁴ Any attempt to label the inheritance of myopia as dominant or recessive fails to consider the many components of refraction: each refractive element has its own mode of transmission; the end result is a product of those components.

Young and Leary⁵ reported that, except for severe hyperopia, refractive characteristics of Inuit parents and children correlate poorly.³ Young⁶ also noted an increased prevalence of myopia in younger people, especially girls. These authors⁵ suggested that vitreous chambers are longer and lenses thinner among Inuit children than among their parents. Much higher correlations of refraction of parents and children have been found in whites.⁷

The prevalence of myopia among this young Inuit population probably reflects exposure to a common environmental factor or factors. Children born since 1944 have undergone some experience different from their older relatives. The lack of correlation of myopia with height, weight and ponderal index suggests the difference is not due to postnatal nutrition, an important determinant of height; in other words, the lack of association of myopia with height indicates no support for the "growth and development" hypothesis based on the assumption that eyeball axial length may be related to some unknown growth factor also reflected in height. One would not, however, expect eyeball axial length to reflect nutrition if it correlates poorly with growth of long bones, as has been suggested.⁸ The lack of such correlation is not surprising, because after birth, skull bones grow far less than long bones. Even though adult myopes and nonmyopes appear not to differ in height, there could have been some difference in their previous rate of growth⁹ or time of growth. A different time of growth might explain some previous data indicating a greater height among myopic children.¹⁰

The higher prevalence among females suggests a postnatal environmental effect, especially a cultural one. One such difference, sex-related, may be schooling. If boys leave school earlier or have more frequent and prolonged absences their chance for accommodative spasm due to close work would diminish. Likewise, boys would be exposed less to artificial light and more to the bright glare of the Arctic day. Primate research indicates that a restriction of visual space may alter growth and refractive

characteristics.^{11,12} Again, one could postulate that the female, raised in a predominantly indoor environment (i.e. school), might have a visual space considerably smaller than that of the male, who is hunting or travelling with his father. Such environmental explanations contradict the statement of one authority⁴ that "exterior factors have no influence at all on myopia".

Our data support the hypothesis that schooling is an etiologic factor in the production of myopia. The females, with their greater frequency of myopia, were more likely to have attended school regularly; their mean number of years registered in school was also slightly greater. Within each sex the myope gave a history of more years of schooling and more regular attendance. The comment has often been made that myopes are "bookish" rather than athletic. In the study population, however, school attendance is probably influenced as much by family patterns of hunting and trapping as by personal interest. The Inuit myope would seem to be a product of schooling rather than one who is attracted to schooling through his incompetence in outdoor (distance vision) activities.

A colleague, O. Shaeffer (personal communication, 1974), has suggested that the variation in refractive error, by schooling, may reflect the different nutritional experiences of students attending residential school. Unfortunately our data do not allow testing of that alternative hypothesis.

Our study does not suggest any immediate steps to prevent myopia. Our findings do indicate the need for more research on the environmental factors under suspicion. Identification of such factors likely would benefit not only the Inuit but all other races.

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